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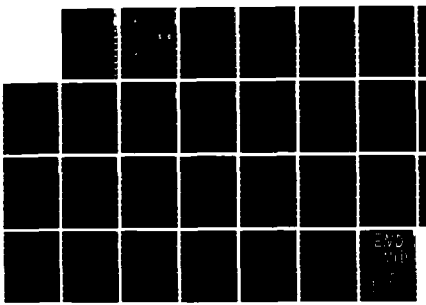

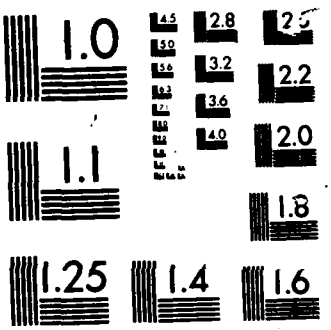

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TECHNICAL REPORT RH-85-3

PCFIT2
GENERAL PURPOSE CURVE FITTING PROGRAM FOR IBM PC

Miles E. Holloman
William F. Otto
Directed Energy Directorate
Research, Development, and
Engineering Center

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AUGUST 1985

U.S. ARMY MISSILE COMMAND
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PCFIT2 is a general purpose curve fitting computer code for use on microcomputers. It utilizes SIMPLEX methodology in a framework into which the user installs the functions of interest.

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I. INTRODUCTION

The personal computer is rapidly finding its place in both the business and scientific/engineering workplace. Desk top models available today surpass the computing power of the largest mainframe of a few years ago. A limit to the utility of these machines is the availability of useful utility routines that perform the functions routinely found on the more conventional computer hardware. The commercial market has reacted well to the demand of the business community and has provided a variety of available business oriented software. However, for the scientific/engineering community notable gaps exist in the available software. To attempt to fill a void that exists at MICOM and suspected to exist elsewhere, the PCFIT series of computer programs was developed for routine plotting, fitting, and interpolating of typical data encountered in the scientific/engineering community.

The PCFIT2 series of programs is a complementary companion series to the earlier PCFIT series of plotting, interpolating, and fitting programs. The PCFIT2 series retains the earlier user-friendly menu driven framework of PCFIT series. PCFIT2 differs from the earlier series in that it is truly a general purpose curve fitting program. A framework is provided into which the user's equations/functions may be readily installed to allow data analysis and fitting in a convenient fashion. The only known limitations on PCFIT2 are that it is limited to one independent variable and the framework limits the number of included functions to twenty. Table I lists the functions initially included in PCFIT2 for convenience. Like PCFIT, the PCFIT2 series is a three member set differing in the hardware requirements to implement and in the form of the graphic output. Table II lists the hardware requirements for each member of the series. In as much as possible the program has the same form and relatively the same input format. PCFIT2M, the simplest of the programs, has very simple "line printer" graphics output and, consequently, limited options. PCFIT2G with stronger graphics capabilities allows the user to select a variety of formats with which to display the graphic output. PCFIT2P, which requires the availability of a Hewlett-Packard plotter, allows the greatest variety in format, color, and the actual number of curves that can be plotted on a single graph. The graphics range from crude to adequate; however, no attempt has been made to provide "professional graphics" in any case. An option is provided to allow curves once generated to be stored in data files for future import to professional plotting programs or other analysis programs.

TABLE I. PCFIT2 Available Functions

PLOTTING DATA ALONE

DATA SMOOTHING

Y = A + B*X

TABLE II. Hardware and Software Requirements

PCFIT2M	192K MEMORY
	MONOCHROME BOARD
	MONOCHROME MONITOR
	PRINTER (FOR HARDCOPY)
	MICROSOFT FORTRAN
PCFIT2G	256K MEMORY
	GRAPHICS BOARD
	GRAPHICS MONITOR
	GRAPHICS PRINTER (FOR HARDCOPY)
	GRAPHMATICS (MICROCOMPATIBLES)
	MICROSOFT FORTRAN
PCFIT2P	256K MEMORY
	HEWLETT-PACKARD PLOTTER
	PRINTER (FOR HARDCOPY)
	PLOTMATIC (MICROCOMPATIBLES)
	MICROSOFT FORTRAN

A. Methodology

The simplex methodology for fitting data is used in PCFIT2. The model is a modification to that of Caceci and Cacheris (Byte, May 1984) differing in primarily two ways. First, the routine has been converted from Pascal to Fortran and, secondly, the convergence criterion has been modified to be more general purpose. Rather than require the establishment of predefined convergence criteria that will be data dependent as to the magnitude, the approach taken was to monitor the "goodness" of the fit until no further improvements were noted for 10 iterations. This has thus far proven to be a reliable general purpose method of naturally terminating the process. It is noted that the simplex method, within the speed and memory limitations of the computer on which it runs, is capable of computing the parameter values that best fit a particular set of data. However, this may be a lengthly process for microcomputers that rely on 8088 processors.

B. Format for Data Files

The data input to the PCFIT2 programs is from data files with the following form:

Line	CONTENT
1	TITLE (up to 50 characters)
2	X-AXIS LABEL (up to 50 characters)
3	Y-AXIS LABEL (up to 50 characters)
4	X(1),Y(1) - list directed format
.	.
.	.
.	.
.	.
N	X(N),Y(N) (up to 200 data pairs)

NOTE: It is recommended that the labels used for the axes be limited to approximately ten characters. Table III illustrates a typical data set that will be used to illustrate the use of each program.

C. The Coefficient of Determination, RSQ

The only statistical information involved in the PCFIT2 series of programs is the coefficient of determination. The program is only intended to give a

TABLE III. Sample Data Set - DATA1.DAT

```
TITLE
X-AXIS
Y-AXIS
1.,2.
1.2,2.2
1.4,2.0
1.6,2.4
1.8,2.1
2.,2.3
2.2,2.5
2.4,2.3
2.6,2.8
2.8,2.4
3.,2.7
3.2,3.1
3.4,2.6
3.6,3.0
3.8,2.9
4.,3.0
4.2,3.2
4.4,3.1
4.6,3.3
4.8,3.2
5.,3.4
5.2,3.2
5.4,3.0
5.6,2.9
5.8,2.5
6.,2.2
```

quick visual look at the abilities of the various options, not a comprehensive statistical "look" at those abilities.

RSQ is given by the following equation:

$$RSQ = 1. - \frac{SSE}{(Y_i - Y)^2}$$

where (x_i, y_i) are a set of N data points

y - arithmetic average of the y_i values

SSE - sum of squares for error

$$SSE = (y_i - y_{\text{calculated at } x_i})^2.$$

If the curve passes through all points, then

RSQ = 1.00.

If the curve misses the data points by large deviations and the data is quite scattered, the RSQ will be small. Thus, RSQ for some options gives an indication of which curves fit the data points "best". CAUTION - Even if RSQ = 1., the curve may behave wildly between data points and/or outside the given data range.

D. Available Options

As illustrated in Table I, two commonly used options are provided in PCFIT2. Option 1 provides for plotting of the data alone and option 2 provides two data smoothing options. These options are direct carry-overs from the earlier PCFIT programs. The remaining option, option 3, is for illustration purposes only and may be replaced by functions of the user's choice. Option 3 is the common linear function.

Data Smoothing, Option 2 - this option performs the user's choice of first or third degree five point smoothing of the current Y array. Each Y value is replaced by the value given by a local least squares curve at the corresponding X. This curve is determined by using the original Y value plus the two original Y values on either side. For the end and next-to-end points, the choice is skewed so as to give a total of five points as close to the end as possible. Data points must be equally spaced in X. Therefore, caution must be shown in using this option.

First degree smoothing is commonly referred to as a moving average. It may be necessary to call the smoothing option several times in succession, smoothing the smoothed data, to yield values acceptable to the user. It is

recommended that gross data outliers be corrected or removed before using least squares smoothing.

E. User Defined Options

PCFIT2 provides a framework into which up to twenty equations/functions may be inserted. For illustration purposes the first of these options is predefined as the linear relationship, Option 3, and is of the form:

$$Y = A + B*X$$

In this section the steps for inclusion of a second function, Option 4, will be illustrated. The function selected for the example is the polynominal in the form:

$$Y = A + B*X + C*X**2 + D*X**3$$

To include additions to the PCFIT2 program framework the user must:

1. Modify appropriate portions of the code
2. Compile the modified code
3. Link the resulting code

F. Code Modification

The code modification for the inclusion of additional functions in the PCFIT2 programs is reasonably straightforward but not simple in that pains were not taken to make this process as streamlined as possible since this would require major modifications to the PCFIT2 framework shared by the previous PCFIT program. Stepwise, the modifications are as follows:

1. Define the new function in FUNCTION FUNC
2. Modify SUBROUTINE SIMPLEX to acknowledge the presence of the new function
3. Define the new function in SUBROUTINE DFUNCT
4. Define the new function in SUBROUTINE PICKD

G. Modifications to Function FUNC

Table IV lists the form and contents of FUNCTION FUNC. Two modifications are required to include the additional function. The GO TO statement, statement

TABLE IV. Function FUNC

```
      FUNCTION FUNC (COEF,D,IEQ)
      DOUBLE PRECISION FUNC
      DOUBLE PRECISION COEF
      DIMENSION COEF(11),D(2)
    1 GO TO (101),IEQ
  101 FUNC=COEF(1)+COEF(2)*D(1)
      RETURN
      END
```

label 1, must be modified to include a destination statement label for the new equation. The variable IEQ is the index of the equation number and equals to the selected option minus 2 to account for the first two options of plotting and smoothing which do not involve any fitting of the data. For the illustration statement label 1 is modified to:

```
1     GO TO(101,102),IEQ
```

where statement label 102 has been selected as the destination when IEQ equals to 2 (Option equals to 4).

The new function, the polynominal, is then inserted into the code and given the statement label 102 and should be located following a RETURN statement located immediately following statement label 101. Thus, the code will assume the form:

```
101  FUNC = COEF(1) + COEF(2)*D(1)

     RETURN

102  FUNC = COEF(1)+COEF(2)*D(1)+COEF(3)*D(1)*D(1)+COEF(4)*D(1)*D(1)*D(1)

     RETURN
```

Inclusion of additional functions will take the same form by modification of statement label 1 and the addition of statements labeled 103, 104, etc.

H. Modifications to Subroutine SIMPLEX

Modifications to SUBROUTINE SIMPLEX take the form of acknowledging the presence of the additional function and identification of the number of coefficients involved in the new function. Table V lists the first portion of this code for reference.

The statement at label 1000 and the following statement must be modified to prevent the selection of nonexistent options. Statement label 1000 and the following statement should be changed in the example to:

```
1000  IF(IEQ.LT.1 .OR. IEQ.GT.2) WRITE(LUI,'(A)') ' INPUT ERROR '

      IF(IEQ.LT.1 .OR. IEQ.GT.2) RETURN
```

As in FUNCTION FUNC, the variable IEQ represents the index of the function and is numerically two less than the option number. The final change to this routine is in the statements following statement label 1035 and takes the

TABLE V. Subroutine Simplex

```
$STORAGE:2
$DEBUG
      SUBROUTINE SIMPLEX
C****
C**** SIMPLEX METHOD
C****
      COMMON LUI,LUO,LUR,IPBUF(50),ICP,A(20),B(20),C(6),P(20),Q7
      COMMON IG(10),RG(10),SX(5,202),SY(5,202),SXX(10,102),SYY(10,102)
      COMMON NPOINT,ITITLE,ICX,ICY,IPX,IPY,NLAG,IXLAB,IYLAB
      COMMON Y(202),XX(102),YY(102),XP(202),XY(4),JBUF(20)
      COMMON  FVALUE(8),NV,JNKEY,NUM,MDEG,JSMDEG,KSMC,NTERMS
      COMMON  NCURV,XXMI,IQ,NN,FK,QL,IFUN,XVAL,YVAL
      COMMON  CC(6),NF(6),S(20),J,JRT,XXL,YYL,YYLD,SSL,XXLS,YYLS
      CHARACTER*1 ITITLE(50),IXLAB(50),IYLAB(50)
      DOUBLE PRECISION CENTER,FINAL,ERROR,RMAXER,PS,Q,STEP,RNEXT,COEF
      DOUBLE PRECISION SIMP,DLOW,DLOWL
      DOUBLE PRECISION FUNC
      DOUBLE PRECISION SQR
      LOGICAL DONE,PRINT,LEQ
      DIMENSION CENTER(14),FINAL(14),ERROR(14),RMAXER(14),
     &PS(14),Q(14),STEP(14)
      DIMENSION IH(14),L(14),SIMP(14,14),RNEXT(14),DATA1(2,200),COEF(14)
      DLOW=1.0D+38
      DLOWL=1.0D+38
      LCNT=0
      IG(4)=0
      IEQ=NUM-2
 1000 IF(IEQ.LT.1.OR.IEQ.GT.1)WRITE(LUI,'(A)') ' INPUT ERROR '
      IF(IEQ.LT.1.OR.IEQ.GT.1) RETURN
      WRITE(LUI,1030)
 1030 FORMAT(' ***** CALCULATING SIMPLEX *****')
      IG(6)=IEQ
C
C     THE FOLLOWING PORTION OF CODE ASSIGNS THE NUMBER OF COEFFICIENTS
C     DEPENDING ON THE OPTION SELECTED - MUST BE UPDATED FOR ADDITIONAL
C     OPTIONS
C
 1035 IF(IEQ.EQ.1)MM=2
C
C
      MM1=MM+1
      NP=NPOINT
```

form of insertion of a line of code to define the number of coefficients in the new function. This line of code is as follows:

```
IF(IEQ.EQ.2) MM = 4
```

Where IEQ is for the second function which has four coefficients.

I. Modifications to Subroutine DFUNCT

SUBROUTINE DFUNCT is used in the MENU OPTION portion of the code to display the available options. Table VI lists the current form of this routine which consists of primarily a variable array FUNCT of character strings that represent each option. The routine provides for up to twenty-two options the first three currently used with the character string "TO BE DEFINED BY THE USER" currently in each of the other elements of the array. To include the example polynominal in the code, change the statement for option 4, FUNCT(4), to read:

```
FUNCT(4) = ' Y = A + B*X + C*X**2 + D*X**3'
```

As addtional functions are added to the code, changes will be made in the remaining variables.

J. Modifications to Subroutine PICKD

The SUBROUTINE PICKD is used to print the form of the function selected, option number, and the value of the coefficients calculated by the fitting routine. In this routine, provision is provied for the addition of up to nineteen functions for a total of twenty-two options. Modification takes the form of the predefined option 3 at statement label 155 and consists of two WRITE statements and a GO TO statement. It is assumed that the additional options will be inserted at statement labels 160, 165, 170 etc. For the example inclusion of the polynominal, the modification takes the form:

```
160  CONTINUE
     WRITE(LUI,'(A)') ' Y = A+B*X+C*X**2+D*X**3'
     IF(LUI.NE.LUO) WRITE(LUO,'(A)') WRITE(LUO,'(A)') 'Y=A+B*X+C**X+D*X**3'
     GO TO 260
```

This completes the modifications to the code necessary to include an additional function. The next step is to compile the modified code using

TABLE VI. Subroutine DFUNCT

```
$STORAGE:2
$DEBUG
      SUBROUTINE DFUNCT
      CHARACTER FUNCT(22)*35
      FUNCT(1)='DATA ALONE                                '
      FUNCT(2)='SMOOTH DATA                               '
      FUNCT(3)='TO BE DEFINED BY THE USER                 '
      FUNCT(4)='TO BE DEFINED BY THE USER                 '
      FUNCT(5)='TO BE DEFINED BY THE USER                 '
      FUNCT(6)='TO BE DEFINED BY THE USER                 '
      FUNCT(7)='TO BE DEFINED BY THE USER                 '
      FUNCT(8)='TO BE DEFINED BY THE USER                 '
      FUNCT(9)='TO BE DEFINED BY THE USER                 '
      FUNCT(10)='TO BE DEFINED BY THE USER                '
      FUNCT(11)='TO BE DEFINED BY THE USER                '
      FUNCT(12)='TO BE DEFINED BY THE USER                '
      FUNCT(13)='TO BE DEFINED BY THE USER                '
      FUNCT(14)='TO BE DEFINED BY THE USER                '
      FUNCT(15)='TO BE DEFINED BY THE USER                '
      FUNCT(16)='TO BE DEFINED BY THE USER                '
      FUNCT(17)='TO BE DEFINED BY THE USER                '
      FUNCT(18)='TO BE DEFINED BY THE USER                '
      FUNCT(19)='TO BE DEFINED BY THE USER                '
      FUNCT(20)='TO BE DEFINED BY THE USER                '
      FUNCT(21)='TO BE DEFINED BY THE USER                '
      FUNCT(22)='TO BE DEFINED BY THE USER                '
      WRITE(*,'(A)') ' '
      WRITE(*,'(A)') ' '
      WRITE(*,'(A)') ' '
      WRITE(*,'(A)')
     +'                              SELECT OPTION'
      WRITE(*,'(A)') ' '
      DO 10 I=1,21,2
      J=I+1
      WRITE(*,'(1X,I2,2X,A,1X,I2,2X,A)') I,FUNCT(I),J,FUNCT(J)
   10 CONTINUE
      RETURN
      END
```

MICROSOFT FORTRAN and finally linking the resulting object codes using MICROSOFT LINKER.

K. Input Guides for PCFIT Programs.

The following three sections contain detailed input guides for PCFTI2M, PCFIT2G, and PCFIT2P, respectively. Many of the sections are identical but have been included in a redundant fashion to facilitate the use of the user's choice of program. The reader should review the appendix of MICOM report TR-RH-85-2 for additional detail in running the programs.

II. PCFIT2M

PCFIT2M is the least demanding as far as hardware, but also is least impressive as to the graphic output provided. The minimum system must have 192K of memory, a monochrome board, and correspondingly, a monochrome monitor. The text only nature of the monitor limits the detail of the graphic output.

A. Input Guide for PCFIT2M

For PCFIT2M as well as the other members of the series, the user inputs are menu driven prompts with an attempt made to make the selections somewhat self-evident for the user. To run PCFITM the user is presented with five menus in order: (1) DATA INPUT MENU, (2) LOG MENU, (3) DATA SCALING MENU, (4) OPTION SELECTION MENU, and (5) PLOTTING MENU. The program is designed such that the user may, having completed one calculation, repeat any of the previous menu selection processes. Additionally, the program does not terminate naturally but allows the user to select alternate curve functions, plotting options, or scaling options without re-entering the data.

B. Data Input Menu - Starting the Program

The program is started by typing the command PCFIT2M following the system prompt. The program enters the "DATA INPUT MENU" initially and prompts the user as to whether printed output is desired.

PRINTED OUTPUT? (Y/N)

This simple option either provides or surpresses output to the printer. The characteristic slowness of typical printers associated with PC type computers may require excessive time as compared to the actual computional times involved, thus supression of printed output may be desired.

The user is then prompted to enter the name of a file containing the data to be analyzed.

ENTER DATA FILE NAME

It is assumed that the data has previously been stored in a data file in the form described in the previous section of this report. The user enters the data file name, the program displays the data on the monitor as it is read and prints a listing if the printing option was selected.

Following this step the user is prompted as to whether additional data files are to be read, thus allowing combining data from more that one file.

ADDITIONAL DATA FILES? (Y/N)

The answer is either "Y" or "N" depending on the situation. PCFIT2P will treat this option somewhat differently and will provide for plotting multiple curves on a single chart.

C. Log Menu

The second menu section is now entered allowing the user the option of performing the plotting, fitting, or interpolations using the logarithm of X and/or logarithm of Y and, independent of this choice, plotting the results in normal, semi-log or log-log form. The user is presented with a menu of the following form:

CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) AND LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING OF DATA

NN - DO NOT USE LOGS AS INPUT OR PLOTTING OF DATA

EX - STOP

Selection of "X", "Y", or "XY" will cause the program to take the log (10) of appropriately X, Y, or X and Y before proceeding with the fitting or interpolation process. Upon completion of the program the data will be returned to the original state. Selection of "N" indicates the logarithm is not to be used in the calculations but allows a future menu selection concerning the plotting of the data. Selection of "NN" provides a presupposed response to the next prompt and provides an early answer that logarithms are not to be used in either the calculations or the plotting of the graphic output. The selection of "EX" terminates the program.

Providing the "NN" option was not selected, the user is prompted for the plotting relative to logarithms:

PLOT LOGS? X Y XY N NN EX

This prompt is analogous to the previous and allows selection of options associated with the plotted output.

D. Data Scaling Menu

The data scaling options menu allows the scaling of the data for plotting purposes, The form of this menu is:

```
SCALE DATA - ENTER S  X  Y  O  E  N  IN ANY ORDER

S - SCALE DATA              X - ORIGIN IS AT X=0

Y - ORIGIN IS AT Y=0        O - USER SPECIFIED ORIGIN

E - END(STOP)               N - NOTHING
```

Prior to plotting the data it must be scaled to provide scaling parameters/ factors to assure that all data will appear within the range of the graphical plot. The selection of the "S" option scales the data in a manner such that the range of the X and Y axes will contain all data. If the data is somewhat integer-like, data points may be located on the axes which may not provide an attractive output plot. To avoid this shortcoming of the scaling, additional scaling options are provided. The selection of "SX", "SY", or "SXY" will scale the data in a manner such that the origin is located at X=0, Y=0, or X=Y=0, respectively. This option, depending on the data, may then displace the curve from the origin. Care should be taken before using this option to assure the data can be represented adequately with its use. If negative numbers are involved, the program will prompt the user to this fact and not allow the option to be used.

While the program selects reasonable numbers for labeling the tic marks on the axes, they may be manually adjusted to the satisfaction of the user by specifying the "SO" option. If the "SO" option is selected, the program will calculate an initial set of scaling parameters and display them to the user in the form of a prompt:

```
ORIGIN AT X =      .80000 STEPS OF      .80000

          ENTER NEW VALUES, OTHERWISE ENTER ,,
```

At this time, the user may elect to use these scaling parameters, by specifying ",,", or enter parameters of his choosing by specifying the value of X(or Y) at the origin and the value of the increment of X(or Y) associated with each major tic mark. It should be noted that the user must select these parameters such that all data is contained within the resulting plot. If the range of the axes is not adequate to contain the data, data points may "wrap around" and appear in strange locations or not appear in the graphic output. The program will check the values thus entered to assure the range is appropriate to contain all data. If the range is found to be inadequate, the user will be prompted in the form:

SPECIFIED ORIGIN LARGER THAN SOME DATA POINTS - RE-ENTER

At this time, the user should enter a new value for the origin. If the range is still found to be inadequate, the user is further prompted by:

STEP SIZE INSUFFICIENT FOR DATA - RE-ENTER

At which time the user can adjust the increments associated with each major tic mark.

E. Option Selection Menu

The following form of information is provided the user with the prompt allowing the user to specify the option of his choice.

SELECT OPTION

1	DATA ALONE	2	SMOOTH DATA
3	Y = A + B*X	4	TO BE DEFINED BY USER
5	TO BE DEFINED BY USER	6	TO BE DEFINED BY USER
7	TO BE DEFINED BY USER	8	TO BE DEFINED BY USER
9	TO BE DEFINED BY USER	10	TO BE DEFINED BY USER
11	TO BE DEFINED BY USER	12	TO BE DEFINED BY USER
13	TO BE DEFINED BY USER	14	TO BE DEFINED BY USER
15	TO BE DEFINED BY USER	16	TO BE DEFINED BY USER
17	TO BE DEFINED BY USER	18	TO BE DEFINED BY USER
19	TO BE DEFINED BY USER	20	TO BE DEFINED BY USER
21	TO BE DEFINED BY USER	22	TO BE DEFINED BY USER

ENTER: # L SA ST DA RS RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE ON FILE	ST - STOP
DA - READ NEW DATA SET	RS - RESTART
RP - REPLOT DATA	EX - EXIT(STOP)

At this point the user is to select the option, 1 - 22, desired or an alternative operation as indicated by the alphabetic codes.

The desired mathematical form of the function with which the data is to be analyzed is selected by the appropriate numerical value 1 - 22.

Option 1 does not perform any analysis of the data but simply allows the user to plot the input values.

Option 2 provides two smoothing techniques, first and third degree, the user will be prompted to select one or the other; a brief help menu is also provided. Once the data is smoothed, the program is re-entered at the scaling menu since the data should now be somewhat more confined in terms of the excursions along the Y axis. The data is then rescaled and subsequently plotted, fitted, interpolated or smoothed as the user desires.

The selection of the "L" option will list on the screen the data being analyzed and return to the menu for further instructions.

The "SA" option allows the user to save the data that makes up the fitted or interpolated curve. This option can only be used if a curve has been generated - that is it cannot be used on the first pass through the program. Assuming one of the eleven fitting/interpolating options has been previously selected and the resulting curve found to be worthy of saving for future use, it may be saved in a separate file by specifying the "SA" option. If this option is selected, the user will be prompted to specify a file name in which to store the data followed by a prompt as to whether the title and axes labels are to be stored also. Depending on the purpose of selecting this option, the answer may be either "Y" or "N". If, for example, the purpose of saving the data is to allow import into a different program, one may not want to save the title and labels, only the X and Y values. Alternatively, if the purpose of selection of this option is to use it as input data to PCFIT, the title and labels would be desired. The curves generated in any of the PCFIT programs consist of one hundred X-Y data pairs. Some programs or some situations may not allow this many data points to be used so options are provided to store 25, 50, or 100 data points. The user is prompted to enter his choice; the method used when either 50 or 25 data points is selected is to store in the file every other or every fourth data point.

The "ST" option simply terminates the program.

The selection of the "DA" option reschedules the program at the beginning allowing a new set of data to be entered. This option causes the program to discard the current data set and prompt the user for the file name of the file containing the new data to be analyzed. This option does not allow the new data to simply be appended to the end of the current data set.

The selection of the "RS" or restart option reschedules the program at the point of the LOG MENU. This option retains the data currently under analysis.

The "RP" or replot option reschedules the program at the point of the SCALING MENU to allow adjustments generally through the use of user specified origin option in this menu.

The "EX" option is an alternate to the "ST" option performing the same function of terminating the program.

Assuming one of the available functions was selected as the form of the data analysis, the program calculates and displays on the monitor the progression of the SIMPLEX routine in the fitting of the data. This progression is displayed in the form of iteration number, current value of the coefficients, and the current error in the fit. Termination occurs when no further improvement in the fit is made for 10 iterations. Upon termination, the final values of the coefficients are displayed on the monitor, and printer if not suppressed, the option selected, a measure of the quality of the fitted/interpolated curve, RSQ, and the appropriate coefficients. This information will be displayed in the form:

```
  OPTION NO.   3

Y= A + B*X

NUMBER OF COEFFICIENTS =  2

RSQ =  .9313

C0 =  .150735E+01

C1 = -.447350E+00
```

F. Plotting Menu

PCFIT2M will automatically provide a "line printer" type display of the specified graphic output on the monitor. The resolution of the monitor is such that much of the detail is lost in the process. The user is prompted as to whether a hard copy is desired:

```
HARD COPY? (Y/N)
```

If the user specifies "Y", the resulting graph is expanded to fill a full sheet of paper adding some detail to the resulting chart.

The program returns to the OPTIONS MENU for specification of additional options.

G. Multiple Plots

Plotting of multiple curves using the low resolution plotting options provided in PCFIT2M is not recommended.

III. PCFIT2G

PCFIT2G provides adequate representation of the data and resulting fitted or interpolated curves on a graphic monitor. The minimum system must have 256K of memory, a color graphics or monochrome graphics board, and correspondingly, a graphics or monochrome monitor. Additionally, the program utilizes the GRAPHMATIC library routines available from MICROCOMPATIBLES that must be supplied by the user. The resolution of the monitor limits the detail of the graphic output.

A. Input Guide for PCFIT2G

For PCFIT2G as well as the other members of the series, the user inputs are menu driven prompts with an attempt made to make the selections somewhat self-evident for the user. To run PCFIT2G the user is presented with five menus in order: (1) DATA INPUT MENU, (2) LOG MENU, (3) DATA SCALING MENU, (4) OPTION SELECTION MENU, and (5) PLOTTING MENU. The program is designed such that the user may, having completed one calculation, repeat any of the previous menu selection processes. Additionally, the program does not terminate naturally but allows the user to select alternate curve functions, plotting options, or scaling options without re-entering the data.

For the purposes of this report a sample data set will be used and will be referred to as DATA1.DAT. Table III contains this data set for reference.

B. Data Input Menu - Starting the Program

The program is started by typing the command PCFIT2G following the system prompt. The program enters the "DATA INPUT MENU" initially and prompts the user as to whether printed output is desired.

PRINTED OUTPUT? (Y/N)

This simple option either provides or surpresses output to the printer. The characteristic slowness of typical printers associated with PC type computers may require excessive time as compared to the actual computional times involved, thus supression of printed output may be desired.

The user is then prompted to enter the name of a file containing the data to be analyzed.

ENTER DATA FILE NAME

It is assumed that the data has previously been stored in a data file in the form described in the previous section of this report. The user enters the

data file name, the program displays the data on the monitor as it is read and prints a listing if the printing option was selected.

Following this step the user is prompted as to whether additional data files are to be read thus allowing combining data from more that one file.

ADDITIONAL DATA FILES? (Y/N)

The answer is either "Y" or "N" depending on the situation. PCFIT2P will treat this option somewhat differently and will provide for plotting multiple curves on a single chart.

C. Log Menu

The second menu section is now entered allowing the user the option of performing the plotting, fitting, or interpolations using the logarithm of X and/or logarithm of Y and, independent of this choice, plotting the results in normal, semi-log or log-log form. The user is presented with a menu of the following form:

CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) AND LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING OF DATA

NN - DO NOT USE LOGS AS INPUT OR PLOTTING OF DATA

EX - STOP

Selection of "X", "Y", or "XY" will cause the program to take the log (10) of appropriately X, Y, or X and Y before proceeding with the fitting or interpolation process. Upon completion of the program the data will be returned to the original state. Selection of "N" indicates the logarithm is not to be used in the calculations but allows a future menu selection concerning the plotting of the data. Selection of "NN" provides a presupposed response to the next prompt and provides an early answer that logarithms are not to be used in either the calculations or the plotting of the graphic output. The selection of "EX" terminates the program.

Providing the "NN" option was not selected, the user is prompted for the plotting relative to logarithms:

PLOT LOGS? X Y XY N NN EX

This is analogous to the previous and allows selection of options associated with the plotted output.

D. Data Scaling Menu

The data scaling options menu allows the scaling of the data for plotting purposes. The form of this menu is:

SCALE DATA - ENTER S X Y O E N IN ANY ORDER

S - SCALE DATA **X - ORIGIN IS AT X=0**

Y - ORIGIN IS AT Y=0 **O - USER SPECIFIED ORIGIN**

E - END(STOP) **N - NOTHING**

Prior to plotting the data it must be scaled to provide scaling parameters/ factors to assure that all data will appear within the range of the graphical plot. The selection of the "S" option scales the data in a manner such that the range of the X and Y axes will contain all data. If the data is somewhat integer-like, data points may be located on the axes which may not provide an attractive output plot. To avoid this shortcoming of the scaling, additional scaling options are provided. The selection of "SX", "SY", or "SXY" will scale the data in a manner such that the origin is located at X=0, Y=0, or X=Y=0, respectively. This option, depending on the data, may then displace the curve from the origin. Care should be taken before using this option to assure the data can be represented adequately with its use. If negative numbers are involved, the program will prompt the user to this fact and not allow the option to be used.

While the program selects reasonable numbers for labeling the tic marks on the axes, they may be manually adjusted to the satisfaction of the user by specifying the "SO" option. If the "SO" option is selected, the program will calculate an initial set of scaling parameters and display them to the user in the form of a prompt:

ORIGIN AT X = .80000 STEPS OF .80000

ENTER NEW VALUES, OTHERWISE ENTER ,,

At this time the user may elect to use these scaling parameters by entering ",,", or enter parameters of his choosing by specifying the value of X(or Y) at the origin and the value of the increment of X(or Y) associated with each

major tic mark. It should be noted that the user must select these parameters such that all data is contained within the resulting plot. The graphic output is such that there are eight (8) divisions along the X axis and five (5) along the Y axis. If the range of the axes is not adequate to contain the data, data points may "wrap around" and appear in strange locations or not appear in the graphic output. The program will check the values thus entered to assure the range is appropriate to contain all data. If the range is found to be inadequate, the user will be prompted in the form:

SPECIFIED ORIGIN LARGER THAN SOME DATA POINTS - RE-ENTER

At this time the user should enter a new value for the origin. If the range is still found to be inadequate the user is further prompted by:

STEP SIZE INSUFFICIENT FOR DATA - RE-ENTER

At which time the user can adjust the increments associated with each major tic mark.

E. Option Selection Menu

The following form of information is provided the user with the prompt allowing the user to specify the option of his choice.

SELECT OPTION

1	DATA ALONE	2	SMOOTH DATA
3	Y = A + B*X	4	TO BE DEFINED BY USER
5	TO BE DEFINED BY USER	6	TO BE DEFINED BY USER
7	TO BE DEFINED BY USER	8	TO BE DEFINED BY USER
9	TO BE DEFINED BY USER	10	TO BE DEFINED BY USER
11	TO BE DEFINED BY USER	12	TO BE DEFINED BY USER
13	TO BE DEFINED BY USER	14	TO BE DEFINED BY USER
15	TO BE DEFINED BY USER	16	TO BE DEFINED BY USER
17	TO BE DEFINED BY USER	18	TO BE DEFINED BY USER
19	TO BE DEFINED BY USER	20	TO BE DEFINED BY USER
21	TO BE DEFINED BY USER	22	TO BE DEFINED BY USER

ENTER: # L SA ST DA RS RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE ON FILE	ST - STOP
DA - READ NEW DATA SET	RS - RESTART
RP - REPLOT DATA	EX - EXIT(STOP)

At this point the user is to select the option, 1 - 22 desired or an alternative operation as indicated by the alphabetic codes.

The desired mathematical form of the function with which the data is to be analyzed is selected by the appropriate numerical value 1 - 22.

Option 1 does not perform any analysis of the data but simply allows the user to plot the input values.

Option 2 provides two smoothing techniques, first and third degree, the user will be prompted to select one or the other; a brief help menu is also provided. Once the data is smoothed, the program is re-entered at the scaling menu since the data should now be somewhat more confined in terms of the excursions along the Y axis. The data is then rescaled and subsequently plotted, fitted, interpolated, or smoothed as the user desires.

The selection of the "L" option will list on the screen the data being analyzed and return to the menu for further instructions.

The "SA" option allows the user to save the data that makes up the fitted or interpolated curve. This option can only be used if a curve has been generated - that is, it cannot be used on the first pass through the program. Assuming one of the eleven fitting/interpolating options has been previously selected and the resulting curve found to be worthy of saving for future use, it may be saved in a separate file by specifying the "SA" option. If this option is selected, the user will be prompted to specify a file name in which to store the data followed by a prompt as to whether the title and axes labels are to be stored also. Depending on the purpose of selecting this option, the answer may be either "Y" or "N". If, for example, the purpose of saving the data is to allow import into a different program, one would not want to save the title and labels, only the X and Y values. Alternatively, if the purpose of selection of this option is to use it as input data to PCFIT2, the title and labels would be desired. The curves generated in any of the PCFIT2 programs consist of one hundred X-Y data pairs. Some programs or some situations may not allow this many data points to be used so options are provided to store 25, 50, or 100 data points. The user is prompted to enter his choice; the method used when either 50 or 25 data points is selected is to store in the file every other or every fourth data point.

The "ST" option simply terminates the program.

The selection of the "DA" option reschedules the program at the beginning allowing a new set of data to be entered. This option causes the program to discard the current data set and prompt the user for the file name of the file containing the new data to be analyzed. This option does not allow the new data to simply be appended to the end of the current data set.

The selection of the "RS" or restart option reschedules the program at the point of the LOG MENU. This option retains the data currently under analysis.

The "RP" or replot option reschedules the program at the point of the SCALING MENU to allow adjustments generally through the use of user specified origin option in this menu.

The "EX" option is an alternate to the "ST" option performing the same function of terminating the program.

Assuming one of the twenty functions was selected as the form of the data analysis, the program calculates and displays on the monitor, and printer if not suppressed, the option selected, a measure of the quality of the fitted/interpolated curve, RSQ, and the appropriate coefficients. This information will be displayed in the form:

```
  OPTION NO.   3

Y=A+B*X

NUMBER OF COEFFICIENTS = 2

RSQ =  .9313

CO =  .150735E+01

C1 = -.4473501E+01
```

F. Plotting Menu

Following the display of the coefficients, the user is presented with the PLOTTING MENU. This menu is for the selection of options associated with the plotting and display of the data points only. The fitted curve is always in the form of one hundred data points that in general are closely spaced to appear as a continuous curve. The plotting option menu has the form:

```
        **** PLOTTING OPTIONS ****

ENTER:  P  A  L  B  D  +  X  *  .  O  H  M  N  E

P - PLOT DATA AS + SYMBOLS      A - PLOT AXES

L - CONNENT DATA POINTS         B - BROKEN LINE

D - USE DIAMOND                 + - USE +

X - USE X                       * - USE *

. - USE .                       O - USE O

H - HIGH RESOLUTION(DEF)        M - MEDIUM RES

N - NOTHING                     E - END(STOP)
```

The user may enter up to ten of the letters in a string to specify the selection of options. However, there are not in general ten options to be selected at any one time.

In order that the input data is plotted, the "P" option must be selected. This option will then plot each data point as a "+" symbol.

The selection of the "A" or axis option includes the axes and axes labels and graph titles in the graphic output.

The "L" option connects the data points by solid lines, while the "B" option connects the data points by broken or dotted lines. These options may be used either independently of or in conjunction with the "P" option. If the combination "PL" or "PB" is used, the data points, "+" symbols, are connected by solid or broken lines. If only "L" or "B" option selected, no symbols will appear on the graph.

The "D", "+", "X", "*", ".", and "O" options must be used in conjunction with the "P" option and specify alternate symbols to be used to represent the data points. The "D" option represents a diamond, ASCII symbol 004, "+" option is a plus sign somewhat larger than the default plus symbol, "X" option is the symbol X, "*" is the symbol *, "." option is a period -recommended if there is a large amount of data and "O" is the symbol O. These options can also be used in conjunction with either option "L" or "B" to connect data point symbols with either solid or broken lines.

The "H" and "M" options specify the resolution of the graphic display. The default value is "H" and is 640 x 200 resolution in monochrome. The medium resolution, "M" option, is 320 x 200 resolution with color if a color monitor is used.

The "N" option returns the program to the previous menu and the "E" option terminates the program.

Once the graphic display has been formed on the monitor, the user is then prompted as to whether a hard copy of the plot is desired.

HARD COPY (Y/N)

Providing the user has a dot matrix printer with graphics capability, the screen can be "dumped" to the printer by specifying "Y".

The program now returns to the OPTIONS MENU for selection of alternate functions or other options available to the user. This process may be repeated indefinitely at the discretion of the user.

G. Multiple Curves

This program provides for only simple options for plotting more than one curve on a single chart. This option will only allow plotting of two or three curves on a single chart by (1) analyzing data set number 1 and saving the preferred curve by specification of "SA" in the OPTIONS MENU, (2) repeat the process for the remaining data sets, (3) re-run PCFIT2G using the "saved curves" as input and combining into a single data set, and finally, (4) plotting the data as individual data points. Since each of these data sets may contain up to 100 data points, the plotted result will appear as a near continuous line on the monitor for each of the data sets. PCFIT2P provides much more impressive graphic output and options for plotting multiple curves on a single chart.

IV. PCFIT2P

PCFIT2P provides adequate representation of the data and resulting fitted or interpolated curves on a Hewlett-Packard plotter. The minimum system must have 256K of memory. Additionally, the program utilizes the PLOTMATIC library routines that must be supplied by the user. The resolution of the plotter limits the detail of the graphic output.

A. Input Guide for PCFIT2P

For PCFIT2P as well as the other members of the series, the user inputs are menu driven prompts with an attempt made to make the selections somewhat self-evident for the user. To run PCFIT2P the user is presented with five menus in order: (1) DATA INPUT MENU, (2) LOG MENU, (3) DATA SCALING MENU, (4) PCFIT22 SELECTION MENU and (5) PLOTTING MENU. The program is designed such that the user may, having completed one calculation, repeat any of the previous menu selection processes. Additionally, the program does not terminate naturally but allows the user to select alternate curve functions, plotting options or scaling options without re-entering the data.

For the purposes of this report, a sample data set will be used and will be refered to as DATA1.DAT. Table III contains this data set for reference.

B. Data Input Menu - Starting the Program

The program is started by typing the command PCFIT2P following the system prompt. The program enters the "DATA INPUT MENU" initially and prompts the user as to whether printed output is desired.

PRINTED OUTPUT? (Y/N)

This simple option either provides or surpresses output to the printer. The characteristic slowness of typical printers associated with PC type computers may require excessive time as compared to the actual computional times involved, thus supression of printed output may be desired.

The user is then prompted to enter the name of a file containing the data to be analyzed.

ENTER DATA FILE NAME

It is assumed that the data has previously been stored in a data file in the form described in the previous section of this report. The user enters the data file name, the program displays the data on the monitor as it is read and prints a listing if the printing option was selected.

Following this step, the user is prompted as to whether additional data files are to be read thus allowing combining data from more that one file.

ADDITIONAL DATA FILES? (Y/N)

The answer is either "Y" or "N" depending on the situation. PCFIT2P treats this option somewhat differently and will provide for plotting multiple curves on a single chart. Plotting of multiple curves will be discussed at the conclusion of this chapter.

C. Log Menu

The second menu section is now entered allowing the user the option of performing the plotting, fitting, or interpolations using the logarithm of X and/or logarithm of Y and independent of this choice, plotting the results in normal, semi-log or log-log form. The user is presented with a menu of the following form:

CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) AND LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING OF DATA

NN - DO NOT USE LOGS AS INPUT OR PLOTTING OF DATA

EX - STOP

Selection of "X", "Y", or "XY" will cause the program to take the log (10) of appropriately X, Y, or X and Y before proceeding with the fitting or interpolation process. Upon completion of the program, the data will be returned to the original state. Selection of "N" indicates the logarithm is not to be used in the calculations but allows a future menu selection concerning the plotting of the data. Selection of "NN" provides a presupposed response to the next prompt and provides an early answer that logarithms are not to be used in either the calculations or the plotting of the graphic output. The selection of "EX" terminates the program.

Providing the "NN" option was not selected, the user is prompted with the prompt for the plotting relative to logarithms:

PLOT LOGS? X Y XY N NN EX

This prompt is analogous to the previous and allows selection of options associated with the plotted output.

D. Data Scaling Menu

The data scaling options menu allows the scaling of the data for plotting purposes. The form of this menu is:

SCALE DATA - ENTER S X Y O E N IN ANY ORDER

S - SCALE DATA **X - ORIGIN IS AT X=0**

Y - ORIGIN IS AT Y=0 **O - USER SPECIFIED ORIGIN**

E - END(STOP) **N - NOTHING**

Prior to plotting the data it must be scaled to provide scaling parameters/ factors to assure that all data will appear within the range of the graphical plot. The selection of the "S" option scales the data in a manner such that the range of the X and Y axes will contain all data. If the data is somewhat integer-like, data points may be located on the axes which may not provide an attractive output plot. To avoid this shortcoming of the scaling, additional scaling options are provided. The selection of "SX", "SY" or "SXY" will scale the data in a manner such that the origin is located at X=0, Y=0, or X=Y=0, respectively. This option, depending on the data, may then displace the curve from the origin. Care should be taken before using this option to assure the data can be represented adequately with its use. If negative numbers are involved, the program will prompt the user to this fact and not allow the option to be used.

While the program selects reasonable numbers for labeling the tic marks on the axes, they may be manually adjusted to the satisfaction of the user by specifying the "SO" option. If the "SO" option is selected, the program will calculate an initial set of scaling parameters and display them to the user in the form of a prompt:

ORIGIN AT X = .80000 STEPS OF .80000

ENTER NEW VALUES, OTHERWISE ENTER ,,

At this time, the user may elect to use these scaling parameters by entering ",,", or enter parameters of his choosing by specifying the value of X(or Y) at the origin and the value of the increment of X(or Y) associated with each major tic mark. It should be noted that the user must select these parameters such that all data is contained within the resulting plot. The graphic output is such that there are eight (8) divisions along the X axis and five (5) along the Y axis. If the range of the axes is not adequate to contain the data,

data points may "wrap around" and appear in strange locations or not appear in the graphic output. The program will check the values thus entered to assure the range is appropriate to contain all data. If the range is found to be inadequate the user will be prompted in the form:

SPECIFIED ORIGIN LARGER THAN SOME DATA POINTS - RE-ENTER

At this time the user should enter a new value for the origin. If the range is still found to be inadequate, the user is further prompted by:

STEP SIZE INSUFFICIENT FOR DATA - RE-ENTER

At which time the user can adjust the increments associated with each major tic mark.

E. Option Selection Menu

The following form of information is provided the user with the prompt allowing the user to specify the option of his choice.

SELECT OPTION

1	DATA ALONE	2	SMOOTH DATA
3	Y = A + B*X	4	TO BE DEFINED BY USER
5	TO BE DEFINED BY USER	6	TO BE DEFINED BY USER
7	TO BE DEFINED BY USER	8	TO BE DEFINED BY USER
9	TO BE DEFINED BY USER	10	TO BE DEFINED BY USER
11	TO BE DEFINED BY USER	12	TO BE DEFINED BY USER
13	TO BE DEFINED BY USER	14	TO BE DEFINED BY USER
15	TO BE DEFINED BY USER	16	TO BE DEFINED BY USER
17	TO BE DEFINED BY USER	18	TO BE DEFINED BY USER
19	TO BE DEFINED BY USER	20	TO BE DEFINED BY USER
21	TO BE DEFINED BY USER	22	TO BE DEFINED BY USER

ENTER: # L SA ST DA RS RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE ON FILE	ST - STOP
DA - READ NEW DATA SET	RS - RESTART
RP - REPLOT DATA	EX - EXIT(STOP)

At this point the user is to select the option, 1 - 22, desired or an alternative operation as indicated by the alphabetic codes.

The desired mathematical form of the function with which the data is to be analyzed is selected by the appropriate numerical value 1 - 22.

Option 1 does not perform any analysis of the data but simply allows the user to plot the input values.

Option 2 provides two smoothing techniques, first and third degree, the user will be prompted to select one or the other; a brief help menu is also provided. Once the data is smoothed, the program is re-entered at the scaling menu since the data should now be somewhat more confined in terms of the excursions along the Y axis. The data is then rescaled and subsequently plotted, fitted, interpolated, or smoothed as the user desires.

The selection of the "L" option will list on the screen the data being analyzed and return to the menu for further instructions.

The "SA" option allows the user to save the data that makes up the fitted or interpolated curve. This option can only be used if a curve has been generated - that is it cannot be used on the first pass through the program. Assuming one of the eleven fitting/interpolating options has been previously selected and the resulting curve found to be worthy of saving for future use, it may be saved in a separate file by specifying the "SA" option. If this option is selected, the user will be prompted to specify a file name in which to store the data followed by a prompt as to whether the title and axes labels are to be stored also. Depending on the purpose of selecting this option, the answer may be either "Y" or "N". If, for example, the purpose of saving the data is to allow import into a different program, one may not want to save the title and labels, only the X and Y values. Alternatively, if the purpose of selection of this option is to use it as input data to PCFIT2, the title and labels would be desired. The curves generated in any of the PCFIT2 programs consist of one hundred X-Y data pairs. Some programs or some situations may not allow this many data points to be used, therefore, so options are provided to store 25, 50, or 100 data points. The user is prompted to enter his choice; the method used when either 50 or 25 data points is selected is to store in the file every other or every fourth data point.

The "ST" option simply terminates the program.

The selection of the "DA" option reschedules the program at the beginning allowing a new set of data to be entered. This option causes the program to discard the current data set and prompt the user for the file name of the file containing the new data to be analyzed. This option does not allow the new data to simply be appended to the end of the current data set.

The selection of the "RS" or restart option reschedules the program at the point of the LOG MENU. This option retains the data currently under analysis.

The "PN" and "LI" options are of primary use when plotting more than one curve on a single graph. These options allow different colored pens and different line types to be used. If the "PN" option is specified, the user will be prompted to enter a pen number. The specification of the "LI" option will result in a prompt allowing the user to specify an alternate line type. The default line type is a solid - the optional line types are specified by entering an integer value from 1 to 6 when prompted. Each of these options results in some form of broken or dashed line varying in the length of the dashes and spaces. See section of this chapter on plotting multiple curves for further information on the use of this option.

The "RP" or replot option reschedules the program at the point of the SCALING MENU to allow adjustments generally through the use of user specified origin option in this menu.

The "EX" option is an alternate to the "ST" option performing the same function of terminating the program.

Assuming one of the twenty functions was selected as the form of the data analysis, the program calculates and displays on the monitor, and printer if not suppressed, the option selected, a measure of the quality of the fitted/ interpolated curve, RSQ, and the appropriate coefficients. This information will be displayed in the form:

```
  OPTION NO.   3

Y=A + B*X

NUMBER OF COEFFICIENTS = 2

RSQ =  .9313

CO =  .150735E+01

C1 = -.447350E+01
```

F. Plotting Menu

Following the display of the coefficients, the user is presented with the PLOTTING MENU. This menu is for the selection of options associated with the plotting and display of the data points only. The fitted curve is always in the form of one hundred data points that in general are closely spaced to appear as a continuous curve. The plotting option menu has the form:

```
READY PLOTTER -- ENTER G  C  A  F  P  N  D  E  ANY ORDER

G - PLOT GRIDS                    C - GRID INTERSECTION PLOTTED

A - PLOT AXES                     F - DRAW FORM

P - PLOT POINTS                   N - NOTHING

H - PLOT HORIZONTAL AXIS          R - PLOT RIGHT AXIS

L - PLOT LEFT AXIS                B - PLOT REVERSE AXES

D - READ ADDITIONAL DATA          E - END(STOP)
```

The user may enter up to ten of the letters in a string to specify the selection of options. However, there are not in general, ten options to be selected at any one time.

Specification of the "G" option will result in a plotted output with grid squares; the "C" option will only mark the intersection of the horizontal and vertical bounds of the grid squares with a "+" . Specification of the "A" option will plot a horizontal and vertical axis with the vertical axis located to the left. The "F" option plots a form around the output.

In order that the input data is plotted the "P" option must be selected. Specifying this option will cause an addition prompt menu to be displayed to allow specification of the pen, nature of plotting, and symbol to be used. This prompt menu is in the form:

ENTER: PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:

PEN	PLOT OPTION	SYMBOL USED
1 - BLACK	-1 - SYMBOL AT EVERY POINT	0 - SQUARE
2 - RED	-2 - SYMBOL AT EVERY 2nd POINT	1 - CIRCLE
3 - GREEN	-N - SYMBOL AT EVERY Nth POINT	2 - TRIANGLE
4 - BLUE	0 - LINE PLOT ONLY	3 - +
5 - YELLOW	1 - LINE AND SYMBOL PLOT	4 - X
6 - ORANGE	2 - LINE AND SYMBOL AT EVERY 2nd POINT	5 - DIAMOND
	N - LINE AND SYMBOL AT EVERY Nth POINT	

The actual colors to be used depend on the arrangement of the pens in the carrousel.

The "N" option does nothing; this option will be used in the plotting of multiple curves to be discussed later. The "H" option plots only a horizontal axis; the "R" and "L" options plot the vertical axis on either the right or left end of the horizontal axis, respectively. The "B" option plots both a horizontal and vertical axis with the vertical axis located on the right of the horizontal. The "D" option re-enters the program at the INPUT DATA MENU for a new data set; current data will be discarded by specifying

this option. Finally, the "E" option terminates the program. The program now returns to the OPTIONS MENU for selection of alternate functions or other options available to the user. This process may be repeated indefinitely at the discretion of the user.

G. Multiple Curves

The PCFIT2 programs are not formulated so as to allow internal "storage" of curves for summary plotting of more than one curve on a graph. However, PCFIT2P can be used to display multiple curves by not replacing the paper and plotting a second curve on the same sheet.

Plotting of multiple curves on a single sheet can be divided in to two different types depending on whether the values or the Y-variables are in the same general range or whether they are vastly different between the curves to be plotted. In either case the X-variable data must be in the same general range for reasonable plots.

If the data is in the same general range, the approach is to first combine all data into a single data set to allow proper scaling, scale the data to establish the scaling parameters, discard this combined data set and enter the first data set, do not re-scale data, plot points, axes, and curve, enter second data set, do not rescale, plot points and curves-no axes this time and repeat until complete. Now in somewhat more detail - in the DATA INPUT MENU the first data set is read followed by the prompt:

ADDITIONAL DATA FILES? (Y/N)

To this prompt the response should be "Y" at which point the second set of data specified by its file name will be entered and appended to the first data set. This process is repeated until all data is entered. The LOG MENU is treated as desired. In the SCALING MENU the selection is as previously described depending on the nature of the data. The combined data is thus scaled to fit within the range of the axes. In the PLOTTING MENU the response should be "D". Specification of the "D" option re-starts the program at the INPUT DATA MENU where the first data file is specified. Proceed as before through the LOG MENU. In the SCALING MENU specify "N" since re-scaling at this point will destroy the previous scaling parameters that encompass all the data sets. In the PLOTTING MENU specify plotting the axes. The data points may also be plotted if desired as may be a curve of the fitted or interpolated data. Having now plotted the first data set, the user is ready to deal with the second data set by entering "D" in the PLOTTING MENU which then prompts the user for the file name of the second data set. Proceed as before through the LOG MENU and SCALING MENU again specifying "N" in the SCALING MENU. The appropriate function for fitting or interpolating is selected from the OPTION MENU and when presented with the PLOTTING MENU, the user may elect to plot the data points. The user should not specify any option that plots axes since this was done previously and are already on the graph. Remaining data sets are processed as data set 2.

For Y-variable data sets that do not lie in the same general range and which have identical X values, combining on a single axis may suppress one set so as not to allow the desired level of detail an alternate approach is suggested. The first data set is processed as one would normally handle a single data set. Without changing the paper in the plotter, the program is re-run with the second data set. The only difference will be in the PLOTTING MENU where the "R" option is specified to plot the Y-axis for this data on the right side of the graph. The X-axis was plotted in the analysis of the first data set..

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